International Journal of Infectious Diseases 17 (2013) e868–e874

Contents lists available at SciVerse ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Marital status and HIV/AIDS mortality: evidence from the US National Longitudinal Mortality Study

Augustine J. Kposowa

Department of Sociology, 1150 Watkins Hall, University of California, Riverside, CA 92521, USA

ARTICLE INFO

Article history:
Received 4 October 2012
Received in revised form 17 February 2013
Accepted 18 February 2013

Corresponding Editor: Eskild Petersen, Aarhus, Denmark

Keywords:
HIV/AIDS mortality
Marital status
Race/ethnicity
Health insurance

SUMMARY

Objectives: The purpose of the study was to examine associations between marital status groups and death from HIV/AIDS. The primary hypothesis was that divorced and single/never married individuals have a much higher risk of death than married persons.
Methods: Data were derived from the third release of the US National Longitudinal Mortality Study. Cox proportional regression models were fitted to the data.
Results: It was found that marital status is associated with mortality from HIV. Divorced and separated individuals were 4.3 times more likely to die of HIV/AIDS than married individuals (adjusted relative risk (aRR) 4.321, 95% confidence interval (CI) 2.978, 6.269). Single/never married persons were 13 times as likely to die of HIV/AIDS as their married counterparts (aRR 13.092, 95% CI 9.652, 17.757). When the sample was stratified by sex, however, it was observed that while marital status was associated with HIV/AIDS mortality among men, it had no significant association with death in women. However, African-American women (aRR 9.23, 95% CI 4.47, 19.03) and Hispanic women (aRR 7.06, 95% CI 3.03, 16.45) had a significantly higher risk of death than their non-Hispanic white female counterparts.
Conclusions: Marital status is a significant risk factor for mortality from HIV/AIDS, but this association is only valid for men. The different gender mortality experiences suggest that for HIV/AIDS more population-based studies comprising marital status risk factor histories are needed, given the limited research on marital status and mortality from the disease.

1. Introduction

Although sexually transmitted diseases (STDs) are largely preventable, they remain a major social and public health problem as well as a leading cause of morbidity, both nationally and internationally.[1] In the USA, there are approximately 19 million new STD cases each year, with almost half of them among persons in the age group 15–24 years.[2]

As for HIV/AIDS, it is estimated that 1.2 million people in the USA are living with the disease, and that 20% of them are not aware of their infection.[3] The annual number of new HIV cases has been relatively stable in the past decade, although new infections remain rather high.[3] About 50 000 Americans become infected with HIV each year, and since the beginning of the HIV epidemic in the early 1980s, an estimated 1 108 611 persons have been diagnosed with the condition.[3,4] US mortality data show that since the start of the HIV epidemic, about 594 500 people with AIDS have died.[3,4]

The biomedical literature on the epidemiology and risk factors for HIV/AIDS infection is extensive, however only a small amount has focused on HIV/AIDS mortality. In the sociological literature, relatively little has been done on the social covariates of HIV/AIDS, even though that discipline has some unique tools (e.g., network analysis) for investigating STDs, including HIV/AIDS. Earlier findings on the excessive rate of transmission among men who have sex with men (MSM) led much of the existing work in the social sciences to concentrate on behavioral risk factors. Some studies have considered poverty and socioeconomic status as risk factors, but this line of research has produced inconsistent results.[5–7] One neglected area of study in both the epidemiological and sociological literature is the association between marital status and HIV/AIDS mortality.[8–10] Frisch and Brønnum-Hansen[11] conducted a population-based study of excess mortality from HIV/AIDS in Denmark, but that investigation was limited to only men and women who had married same sex partners; other marital status categories were not considered. An Australian study on socio-demographic aspects of male mortality from HIV/AIDS[12] presented only descriptive statistics (percentage distributions) of marital status groups and failed to perform a multivariate analysis.

E-mail addresses: Augustine.kposowa@ucr.edu, ajkposowa@gmail.com.

1201-9712/$36.00 – see front matter © 2013 International Society for Infectious Diseases. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ijid.2013.02.018

Prominent epidemiological conceptual models on HIV/AIDS transmission, for example the proximate-determinants approach, ignore marital status as a risk factor.[13] Nationally representative population-based studies on the link between marital status and mortality from HIV/AIDS are rare.

The purpose of this study was to capitalize on recently available data and add to the literature by investigating the impact of marital status on HIV/AIDS mortality. Specifically, answers to the following questions were sought: (1) Are divorced and separated persons more likely to die of HIV/AIDS? (2) Are single/never married individuals more or less likely to die of HIV/AIDS? (3) Do any observed associations between marital status and HIV/AIDS hold equally for both men and women?

2. Methods

2.1. Data source

Data were derived from the third release of the US National Longitudinal Mortality Study (NLMS) public use file. The NLMS is a prospective study of mortality in the non-institutionalized population of the USA, and is conducted by the National Heart, Lung, and Blood Institute in collaboration with the National Center for Health Statistics and the US Bureau of the Census.[14] The samples were derived from the Current Population Surveys (CPS), which are conducted by the US Bureau of the Census.[15]

In the CPS, a probability sample of households is surveyed monthly through personal and telephone interviews to obtain information on social, economic, and demographic characteristics of the US population.[15] The public use data file employed in the present study consisted of a cohort of 11 national samples derived from the CPS conducted in 1980, 1981, 1982, and 1983. Weights on the records were adjusted to reflect the non-institutionalized population distribution of the USA as of April 1, 1983.[15] It was assumed that the 11 surveys collected in 1980, 1981, 1982, and 1983, reflect the US non-institutionalized population as on April 1, 1983. Thus, the 11 samples were combined and considered as one large sample taken on April 1, 1983. Original weights were re-weighted to reflect the size of the US population at that time.[14] The samples were then designated as 'cohorts' for mortality follow-up and survival analysis. The individuals were known to be alive on the survey date and, therefore, eligible for follow-up with regard to survivorship from April 1983. The mortality experiences of sample members were studied until 1994. Data from death certificates on the fact and cause of death were combined with the socioeconomic and demographic characteristics of the 1983 population cohorts using the National Death Index (NDI) to link the two databases. A more detailed description of the data collection process, including sample selection has been presented elsewhere.[14]

2.2. Variables and measures

The dependent variable was the risk of mortality from HIV (042). Cause of death was identified using the International Classification of Diseases, 9th Revision, Clinical Modification.[16] In estimating the risk of HIV/AIDS mortality, all persons surviving beyond the 11-year follow-up, as well as persons dying of other causes were treated as right-censored observations.

The sample comprised 762 727 individuals aged 15 years and above at the beginning of the study, of whom 410 had died from HIV/AIDS by the end of the 11-year follow-up period. The present analysis was restricted to mortality among non-Hispanic white, non-Hispanic African-American, Hispanic males and females, and non-Hispanic other races. The risk of mortality was estimated as a function of marital status.

Marital status was measured by three dummy variables, one for single, one for widowed, and one for those separated or divorced. Those married at the beginning of the study constituted the reference category.

Health insurance availability was measured as a dummy variable. Persons who had no health insurance (public or private) were coded 1, and the reference group comprised individuals with health insurance.

Race/ethnicity was defined in terms of four dummy variables, one for non-Hispanic African-Americans, one for Hispanics, and one for other non-white races (including Asian and Pacific Islanders/Native Hawaiians, Native Americans, and Alaskan natives). Non-Hispanic whites constituted the reference group.

Place of residence was measured in terms of whether an individual lived in an urban or rural area. Those living in urbanized areas (2500 or more people) were coded 1, and persons living in rural areas were the reference group.

Region of residence was measured as a dummy variable with southern residence coded 1, and residence in other states coded 0. The US Census Bureau divides the country into nine census regions. Southern region identification in this paper was based on the classification (code 3) employed by the Bureau at the time of the CPS interviews.[15] Investigations based on aggregates in the social sciences have observed a positive association between residence in these states and higher mortality from other causes of death, including homicide.[17,18] One theory that has been advanced to explain the higher mortality in the south is the prevalence and persistence of poverty. The inclusion of the variable (region of residence) is to determine if the aggregate results can be reproduced at the level of the individual.

Nativity status was measured as a dummy variable. Persons born outside the USA (immigrants) were coded 1, and the native-born were the reference group for comparison.

Housing tenure was measured as a dummy variable. Respondents who lived in rental housing were coded 1, and those who owned their own homes constituted the reference group.

Sex was measured as a dummy variable with males coded 1; women were the reference group for comparison.

Education was measured by three dummy variables, one for less than high school education, and one for high school education (12 years completed). Persons with some college, including Bachelors, graduate, or professional degrees (13 or more years) constituted the reference group.

Annual family income (adjusted for inflation) was indexed by five dummy variables, one each for less than $10 000, $10 000–$19 999, $20 000–29 999, $30 000–$39 999, one for $40 000–$49 999, and one for unknown income. Those with a family income of $50 000 or more were the omitted group.

Age at baseline was captured by defining it in terms of a series of dummy variables, one each for age groups 15–24, 25–29, 30–39, and 40–49 years. The age group 50 years or above served as the reference category.

2.3. Statistical methods

Cox's[19] proportional hazards model was applied to the NLMS data to compare the risk of suicide among marital status groups while controlling for confounders. The Cox model may be specified as: $h(t) = h_0(t)\exp(\Sigma_k ß_k X_k)$, where $h(t)$ is the hazard or risk of mortality at time t, $ß_k$ are a set of unknown parameters to be estimated, and X_k are k covariates. $h_0(t)$ is a baseline hazard function and is defined when all the covariates in the model are set to zero. Model parameters were estimated by the method of partial maximum likelihood using the PHREG procedure available within SAS, version 9.3.[20]

3. Results

In an effort to assess the relationship between key variables and the response variable, analysis began by examining bivariate associations. Event counts, population at risk, and gross (unadjusted) effects of all covariates are shown in Table 1. Of the initial cohort of 763 137 at baseline, 410 individuals died of HIV/AIDS during the 11-year follow-up. As may be seen in the table, divorced and separated persons were 5.8 times more likely to die of HIV/AIDS than married persons. Single/never married individuals experienced AIDS deaths that were over 23 times higher than those experienced by married individuals. Widowhood was not significantly associated with HIV/AIDS mortality. Results also showed that persons without health insurance were nearly 2.2 times as likely to die from HIV/AIDS as those with health insurance.

Non-Hispanic African-Americans were 4 times more likely to die than non-Hispanic whites; similarly, Hispanics were nearly 2.4 times as likely to die of HIV/AIDS as their non-Hispanic white counterparts. There was no association between nativity and HIV/AIDS mortality. Housing tenure was related to mortality in that persons living in rental housing were 3.6 times more likely to die of HIV/AIDS as those living in their own homes. College education elevated HIV/AIDS mortality risk compared to less than high school education. Low family income was associated with a significantly higher risk of HIV/AIDS death. Southern residence was negatively associated with HIV/AIDS death, and individuals living in urban areas were 6.5 times more likely to die of the disease than those living in rural areas.

The next stage of the analysis considered whether the impact of marital status and health insurance on HIV/AIDS mortality was reduced or eliminated when other variables, mainly socioeconomic covariates were controlled. Relevant results of the multivariate analysis are presented in Table 2. Model 1 of Table 2 shows marital status and health insurance adjusted for all other variables, except measures of socioeconomic position (education and family income).

As may be observed, widowed persons were over 2.9 times as likely to die of HIV/AIDS as their married counterparts (adjusted relative risk (aRR) 2.962, 95% confidence interval (CI) 1.152, 7.613).

Table 1
Gross (unadjusted) hazards regression results of the effects of the covariates on HIV mortality, 1983–1994

Covariate	Event	Population at risk	β	RR	95% CI
Marital status					
Married	60	448 843	Ref.	1.000	Ref.
Widowed	5	48 281	0.614	1.849	0.722, 4.736
Divorced/separated	56	63 357	1.767[a]	5.853	4.076, 8.405
Single/never married	287	198 226	3.141[a]	23.140	17.247, 31.048
Health insurance					
Has health insurance	349	708 978	Ref.	1.000	Ref.
Lacks health insurance	61	53 749	0.780[a]	2.183	1.925, 4.322
Sex					
Female	52	403 259	Ref.	1.000	Ref.
Male	358	359 468	2.028[a]	7.599	5.680, 10.165
Race					
Non-Hispanic white	236	619 675	Ref.	1.000	Ref.
Non-Hispanic African-American	114	70 020	1.431[a]	4.181	3.342, 5.231
Hispanic	51	50 297	0.859[a]	2.362	1.745, 3.198
Other non-white race	8	22 175	−0.175	0.840	0.415, 1.698
Nativity status					
Native born	400	736 080	Ref.	1.000	Ref.
Foreign born	10	26 647	−0.346	0.707	0.378, 4.576
Housing tenure					
Lives in own home	149	532 476	Ref.	1.000	Ref.
Lives in rental housing	261	230 251	1.300[a]	3.670	2.990, 4.506
Educational attainment					
Less than high school	87	243 340	Ref.	1.000	Ref.
High school	112	279 677	−0.133	0.875	0.657, 1.165
Some college	211	239 710	0.549[a]	1.733	1.333, 2.253
Family income					
$50 000 +	61	196 392	Ref.	1.000	Ref.
$40 000–$49 999	15	46 928	−0.021	0.979	0.556, 1.723
$30 000–$39 999	50	112 183	0.317	1.374	0.945, 1.998
$20 000–$29 999	108	153 105	0.831[a]	2.296	1.675, 3.147
$10 000–$19 999	92	134 320	0.966[a]	2.629	1.898, 3.640
<$10 000	84	119 799	1.246[a]	3.476	2.468, 4.897
Income unknown	11	26 496	−0.806	0.447	0.237, 0.843
Region of residence					
Outside the south	388	650 710	Ref.	1.000	Ref.
In the south	22	112 017	−1.106[a]	0.331	0.215, 0.508
Place of residence					
Rural	29	249 510	Ref.	1.000	Ref.
Urban	381	513 217	1.874[a]	6.515	4.466, 9.505
Age, years					
50+	31	228 624	Ref.	1.000	Ref.
15–24	99	183 161	1.120[a]	3.066	2.048, 4.589
25–29	73	91 344	1.512[a]	4.540	2.982, 6.910
30–39	155	154 388	1.746[a]	5.731	3.897, 8.426
40–49	52	105 210	1.057[a]	2.879	1.845, 4.491
Events	410				
Population at risk		762 727			

RR, relative risk; CI, confidence interval. Note: all bivariate models were age-adjusted.
[a] Significant at $\alpha = 0.01$.

Table 2
Hazards regression results of the effects of marital status and health insurance coverage on HIV mortality, 1983–1994

Covariate	Model 1[a]		Model 2[b]	
	RR	95% CI	RR	95% CI
Marital status				
Married	1.000	Ref.	1.000	Ref.
Widowed	2.962[c]	1.152, 7.613	2.948[c]	1.145, 7.592
Divorced/separated	4.528[c]	3.128, 6.554	4.321[c]	2.978, 6.269
Single/never married	14.237[c]	10.535, 19.239	13.092[c]	9.652, 17.757
Health insurance				
Has health insurance	1.000	Ref.	1.000	Ref.
Lacks health insurance	1.253	0.950, 1.652	1.275	0.962, 1.690
Sex				
Female	1.000	Ref.	1.000	Ref.
Male	8.161[c]	6.078, 10.957	8.273[c]	6.157, 11.117
Race				
Non-Hispanic white	1.000	Ref.	1.000	Ref.
Non-Hispanic African-American	2.555[c]	2.033, 3.210	2.874[c]	2.270, 3.639
Hispanic	1.848[c]	1.352, 2.526	2.213[c]	1.608, 3.045
Other non-white race	0.700	0.344, 1.423	0.714	0.351, 1.452
Nativity status				
Native born	1.000	Ref.	1.000	Ref.
Foreign born	0.542	0.285, 1.032	0.535	0.281, 1.020
Housing tenure				
Lives in own home	1.000	Ref.	1.000	Ref.
Lives in rental housing	1.962[c]	1.587, 2.426	1.752[c]	1.398, 2.197
Region of residence				
Outside the south	1.000	Ref.	1.000	Ref.
In the south	0.326[c]	0.212, 0.502	0.336[c]	0.219, 0.517
Place of residence				
Rural	1.000	Ref.	1.000	Ref.
Urban	4.085[c]	2.785, 5.991	3.843[c]	2.614, 5.650
Educational attainment				
Less than high school			1.000	Ref.
High school			1.391[d]	1.040, 1.862
Some college			2.245[c]	1.697, 2.970
Family income				
$50 000 +			1.000	Ref.
$40 000–$49 999			0.863	0.489, 1.523
$30 000–$39 999			1.197	0.818, 1.750
$20 000–$29 999			1.633[c]	1.174, 2.271
$10 000–$19 999			1.498[d]	1.054, 2.129
<$10 000			1.521[d]	1.038, 2.229
Income unknown				
Age, years				
50 +	1.000	Ref.	1.000	Ref.
15–24	0.419[c]	0.270, 0.651	0.449[c]	0.288, 0.699
25–29	1.168	0.747, 1.827	0.960	0.609, 1.514
30–39	2.904[c]	1.939, 4.350	2.428[c]	1.608, 3.666
40–49	2.294[c]	1.455, 3.617	2.119[c]	1.340, 3.350
Event		410		410
Population at risk		762 727		762 727
LRS		1216.66[c]		1262.31[c]
df		16		24

RR, relative risk; CI, confidence interval; LRS, Likelihood Ratio Statistic; df, degrees of freedom. Note: a CI that encompasses 1 illustrates a statistically non-significant covariate category.

[a] Model 1 adjusted for age, sex, insurance coverage, place of residence, and region of residence.

[b] Model 2 adjusted for education and income.

[c] Significant at $\alpha = 0.01$.

[d] Significant at $\alpha = 0.05$.

Divorced/separated individuals experienced HIV/AIDS mortality risk that was 4.5 times higher than that experienced by married individuals (aRR 4.528, 95% CI 3.128, 6.554). Single/never married persons were over 14 times more likely to die of the disease during follow-up than their married counterparts (aRR 14.237, 95% CI 10.535, 19.239). Health insurance, which was previously significant at the bivariate level, lost statistical significance in the multivariate analysis as shown in model 1. The results on marital status held after controlling for the potentially confounding effects of sex, race/ethnicity, nativity status, housing tenure, region of residence, and place of residence.

Non-Hispanic African-Americans had HIV/AIDS mortality risk that was nearly 2.6 times that of non-Hispanic whites. Hispanics were over 1.8 times more likely to die of HIV/AIDS than non-Hispanic whites. Individuals living in rental housing had elevated HIV/AIDS mortality risk compared to their counterparts owning their own homes. Southern residence was negatively associated with HIV/AIDS death, and individuals living in the urban environment were 4 times as likely to die of HIV/AIDS as those living in rural areas.

Next, socioeconomic position (indexed by educational attainment and family income) was entered into the equation in an effort to determine whether the impact of marital status would be reduced or eliminated. Results are shown in Table 2, model 2. Inclusion of socioeconomic status was a significant improvement on the model as a whole, based on a likelihood ratio test. The change in log likelihoods resulting from subtracting that of the

Table 3
Hazards regression results of the effects of marital status on HIV mortality, 1983–1994; men and women separately

Covariate	Males		Females	
	RR	95% CI	RR	95% CI
Marital status				
Married	1.00	Ref.	1.00	Ref.
Divorced/separated	6.29[a]	4.19, 9.44	1.01	0.42, 2.43
Single/never married	13.51[a]	9.55, 19.11	1.87	0.87, 4.02
Race				
Non-Hispanic white	1.00	Ref.	1.00	Ref.
Non-Hispanic African-American	2.69[a]	2.08, 3.49	9.23[a]	4.47, 19.03
Hispanic	2.05[a]	1.45, 2.90	7.06[a]	3.03, 16.45
Housing tenure				
Lives in own home	1.00	Ref.	1.00	Ref.
Lives in rental housing	2.06[a]	1.62, 2.61	1.58	0.82, 3.06
Place of residence				
Rural	1.00	Ref.	1.00	Ref.
Urban	4.02[a]	2.62, 6.18	1.76	0.72, 4.28
Educational attainment				
Less than high school	1.00	Ref.	1.00	Ref.
High school	1.98[a]	1.43, 2.74	1.02	0.55, 1.90
Some college	4.01[a]	2.97, 5.41	0.77	0.33, 1.77
Family income				
$30 000 +	1.00	Ref.	1.00	Ref.
$20 000–$29 999	1.63[a]	1.24, 2.15	2.19	0.68, 7.01
$10 000–$19 999	1.35	0.99, 1.83	3.32[b]	1.12, 9.81
<$10 000	1.03	0.72, 1.48	6.14[a]	2.11, 17.87
Income unknown	0.99	0.48, 2.09	0.74	0.17, 3.23
Age	1.03[a]	1.02, 1.04	0.99	0.97, 1.02
Event	358		52	
Population at risk	359 468		403 259	
LRS	741.54[a]		131.77[a]	
df	13		13	

RR, relative risk; CI, confidence interval; LRS, Likelihood Ratio Statistic; df, degrees of freedom. Note: a CI that encompasses 1 illustrates a statistically non-significant covariate category.
[a] Significant at $\alpha = 0.01$.
[b] Significant at $\alpha = 0.05$.

previous (reduced) model from the log likelihood of the expanded model (with socioeconomic status) was 45.65. Given that this is distributed as a Chi-square,[21,22] a test of significance was determined by calculating degrees of freedom (24 − 16 = 8) and comparing the calculated Chi-square (45.65) to the reference value (15.507, $\alpha = 0.05$).

As may be seen in Table 2, when measures of socioeconomic status were added, there was a negligible reduction in the magnitude of the relative risks associated with marital status. The divorced/separated continued to have HIV/AIDS mortality risk that was over 4 times higher than that of the married (aRR 4.321, 95% CI 2.978, 6.269). Single/never married cohort members were 13 times as likely to die during follow-up as their married counterparts (aRR 13.092, 95% CI 9.652, 17.757). Widowed persons were 2.9 times more likely to experience HIV/AIDS mortality than married persons (aRR 2.948, 95% CI 1.145, 7.592).

As for socioeconomic position, individuals with a completed high school education were 39% more likely to die of HIV/AIDS than those with less than high school education. Likewise, those with a college education were 2.2 times as likely to die of HIV/AIDS as their counterparts with less than high school education. Persons in the lower income brackets experienced a significantly higher risk of HIV/AIDS mortality than those further up the income ladder. For instance, individuals with a family income of $20 000 to $29 999 were 63% more likely to die of AIDS than those with a family income of $50 000 or above. Similarly, persons with a family income of $10 000–$19 999 were nearly 50% as likely to die as those with an income of $50 000 or above. Likewise, individuals with a family income below $10 000 were 1.5 times more likely to die of AIDS than those making $50 000 or more.

In the final stage of the analysis, effort was made to answer the final research question of the paper: Do any observed associations between marital status and HIV/AIDS hold equally for both men and women? To address this question, the sample was stratified by gender; relevant hazards regression estimates are shown in Table 3. It is important to point out that for the analysis shown in Table 3, variables such as health insurance availability, nativity status, and region of residence were removed. This was to account for the reduced female sample size. Age was also entered into the equation in its continuous format. Furthermore, to eliminate the risk of empty cells that could render results invalid, any cell with an expected frequency of 5 or less was eliminated. For instance, widowhood was removed as a covariate category because the frequency count in the female subsample was only 2. Family income was collapsed into fewer categories. Sensitivity analyses showed that these precautions did not lead to a bias in results, especially given that the deletion of categories was done to both sub-samples.

As shown in Table 3, divorced and separated men were nearly 6.3 times more likely to die of AIDS than their married counterparts (aRR 6.29, 95% CI 4.19, 9.44). In the female sub-sample, however, there was no significant association between divorce/separation status and AIDS deaths. Similarly, while single/never married men were 13.5 times as likely to die of HIV/AIDS (aRR 13.51, 95% CI 9.55, 19.11), the relative risk for females did not reach statistical significance. To further determine whether there was a significant difference between men and women regarding the effect of marital status on HIV deaths, the ratio of the relative risk (RRR) was calculated using a procedure suggested by Altman and Bland[23] for single/never married status; it was 7.22, and the subsequent test of interaction (z-score) was 4.61, which was statistically significant. These results showed that single/never married status operates very differently for men and women with regard to its association with HIV/AIDS. When the two gender groups were compared on

divorce/separation, the RRR was 6.23 and its associated *z*-score was 3.71, which was also statistically significant.

Another result worth noting after stratifying the sample was that substantial disparities in mortality were observed by race in the female sub-sample. While non-Hispanic African-American men were nearly 2.7 times as likely to die of HIV/AIDS as their white counterparts (aRR 2.69, 95% CI 4.19, 9.44), non-Hispanic African women experienced a death risk that was over 9.2 times greater than that of non-Hispanic white women (aRR 9.23, 95% CI 4.47, 19.03). A similar death profile emerged with regard to Hispanics. Hispanic men were over 2 times (aRR 2.05, 95% CI 1.45, 2.90) more likely to die of HIV/AIDS than non-Hispanic white women, but Hispanic women were over 7 times as likely to die of HIV/AIDS as non-Hispanic white women (aRR 7.06, 95% CI 3.03, 16.45). As for socioeconomic factors, it was observed that while education was a significant risk factor for men, low income was a significant risk factor for women, but not education.

4. Discussion

This study examined the risk of HIV/AIDS mortality across marital status groups using a nationally representative sample. Data analysis revealed that marital status is associated with death from HIV/AIDS. The strongest associations were found between single/never married and the divorced/separated. Furthermore, the influence of marital status on HIV/AIDS mortality risk was not reduced or eliminated when adjustments were made for potentially confounding variables such as race/ethnicity, age, education, income, and health insurance.

How could the linkage between marital status and HIV/AIDS be explained? It may well be that marriage confers buffering and many other advantages that other statuses do not. One major advantage provided by marriage is a stable sexual network. The term sexual network describes a group of individuals connected through sexual contact.[7] It has been shown in some studies[24,25] that sexual networks play a critical role in the spread and acquisition of STDs. Simply put, individuals with more sexual partners may be at higher risk of contracting STDs (including AIDS) than those with reliable partners. It is plausible that single/never married persons and the divorced/separated have a wider sexual network, leading to more sexual partners, which in turn elevates their risk of acquiring HIV/AIDS and subsequently dying from it.

Another plausible explanation for the much higher mortality experienced by divorced/separated and single/never married persons may stem from the lower social integration among the above groups relative to married persons. Durkheim[26] originally coined the concept social integration to refer to the strength of a person's ties to society and the stability of social relations within that society. Among marital status groups, the married are usually considered the most integrated, while the divorced/separated are the least integrated.[21] According to Durkheim,[26] marriage offers a sense of cohesiveness and support that is not available to single, divorced, and widowed persons. Marriage is also a form of social control,[21,28] which in effect works to limit the number of sexual partners that a spouse in the union may legally have.

Analyses further showed that marital status may be a critical factor for men but less so for women, because the gender-specific results showed no marital status differentials in HIV/AIDS mortality in the female sub-sample. How could such an outcome be explained? It is plausible that the single/never married male group has different HIV transmission risks than the married group. Likewise, divorced and separated men have more varied transmission risks than the married. It may well be that the high risk experienced by the single/never married is a direct or indirect result of MSM. It should be noted that the samples were selected for follow-up in the early days of the HIV epidemic in the USA when 'MSM' was considered an efficient transmission route of the virus without adequate protection during intercourse. As for divorced and separated men, it is likely that their higher risk may stem in part from their participation in sexual markets or networks that generate more sexual partners. The sexual market/network explanation has received widespread support in the epidemiology literature.[7,18,24–26]

The above explanations would have been more powerful had analyses been done incorporating risk factor histories of the various covariate categories, especially marital status, but unfortunately no risk factor history was surveyed by the NLMS. This constitutes one limitation of the present study. The second limitation lies in the fact that HIV disease has a long incubation period, and it is likely that some cohort members were infected by the virus before other baseline measures were collected. It is conceivable that some people's HIV status influenced their marital status before data collection. Third, marital status is a time varying covariate, and the length of time that a given individual was in a particular marital status category could not be ascertained from the data. Finally, matrimonial selection cannot be ruled out, in the sense that persons already in good health and deemed to be less at risk of HIV/AIDS may be more likely to find marriage partners than individuals in poor health.

Despite the above limitations, the findings here further add to our understanding of the effect of marital status on HIV/AIDS mortality. To our knowledge, this is the first study that has employed a population-based (nationally representative) sample to investigate the association between marital status and death from HIV/AIDS. Findings with regard to race are also profound in the sense that African-American and Hispanic women died of HIV/AIDS at such high rates.

Conflict of interest: No conflict of interest to declare.

References

1. World Health Organization. Closing the gap in a generation: health equity through action on the social determinants of health. Report from the Commission on Social Determinants of Health. Geneva: WHO; 2008. Available at: http://www.who.int/social_determinants/thecommission/finalreport/en/index.html (accessed February 5, 2012).
2. Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2010. Atlanta, GA: CDC; 2011. Available at: http://www.cdc.gov/std/stats (accessed January 10, 2012).
3. National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention. HIV in the United States. Atlanta, GA: CDC; 2011. Available at: http://www.cdc.gov/HIV (accessed January 20, 2012).
4. National Center for Health Statistics. Health, United States, 2010: with special feature on death and dying. Hyattsville, MD: NCHS; 2011.
5. Evian C. AIDS and the socio-economic determinants of the epidemic in Southern Africa. *J Trop Pediatr* 1994;**40**:61–2.
6. Butler C. HIV and AIDS, poverty, and causation. *Lancet* 2000;**356**:1445–6.
7. Adimora AA, Schoenbach VJ. Social context, sexual networks, and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Diseases* 2005;**191**(Suppl 1):s115–22.
8. Dembo R, Childs K, Belenko S, Schmeidler J, Wareham J. Gender and racial differences in risk factors for sexually transmitted diseases among justice-involved youth. *Neurobehav HIV Med* 2009;**1**:9–14.
9. Buelna C, Ulloa EC, Ulibari MD. Sexual relationship power as a mediator between dating violence and sexually transmitted infections among college women. *J Interpers Violence* 2009;**24**:1338–57.
10. Jemmott LS, Jemmott III JB, O'Leary A. Effects on sexual risk behavior and STD rate of brief HIV/STD prevention interventions for African American women in primary care settings. *Am J Public Health* 2007;**97**:1034–40.
11. Frisch M, Brønnum-Hansen H. Mortality among men and women in same-sex marriage: a national cohort study of 8333 Danes. *Am J Public Health* 2009;**99**:133–7.
12. Burnley IH. Socio-demographic and spatial aspects of male mortality from HIV-AIDS related diseases in New South Wales, Australia, 1990–1994. *Soc Sci Med* 1999;**49**:751–62.
13. Boerma JT, Weir SS. Integrating demographic and epidemiological approaches to research on HIV/AIDS: the proximate-determinants framework. *J Infect Dis* 2005;**191**(Suppl 1):s61–7.
14. US Department of Commerce. National Longitudinal Mortality Study release 3 documentation. Washington, DC: Economics and Statistics Administration, US Census Bureau; 2008.

15. US Department of Commerce. The Current Population Surveys. Washington, DC: US Bureau of the Census. Available online at: http://www.census.gov/cps/ (accessed June 20, 2012).
16. Practice Management Information. ICD.9.CM International Classification of Diseases 9th Revision Clinical Modification (fifth edition). Los Angeles: Practice Management Information, Inc.; 1998.
17. Pinkney A. Black Americans. Upper Saddle River, NJ: Prentice-Hall; 2000.
18. Reif S, Gennoti KL, Whetten K. HIV and AIDS in the Deep South. *Am J Public Health* 2006;**96**:970–3.
19. Cox DR. Regression models and life tables (with discussion). *J R Stat Soc* 1972;**34B**:187–220.
20. SAS Institute. SAS Stats: the PHREG procedure version 9.3 [computer software]. Cary, NC: SAS Institute, Inc.; 2012.
21. Kposowa AJ. Marital status and suicide in the National Longitudinal Mortality Study. *J Epidemiol Community Health* 2000;**54**:254–61.
22. Kleinbaum DG. Survival analysis. New York: Springer; 1996.
23. Altman DG, Bland JM. Interaction revisited: the difference between two estimates. *BMJ* 2003;**326**:219.
24. Klovdahl AS, Potterat JJ, Woodhouse DE, Muth JB, Darrow WW. Social networks and infectious diseases: the Colorado Springs Study. *Soc Sci Med* 1994;**38**: 79–88.
25. Koopman JS, Lynch JW. Individual and causal models and population system models in epidemiology. *Am J Public Health* 1999;**89**:1170–4.
26. Durkheim E. Suicide: a study in sociology. New York: The Free Press; 1897.
28. Stack S, Kposowa AJ. Religion and suicide acceptability: a cross-national analysis. *J Sci Study Relig* 2011;**50**:289–306.